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# Consumer flexibility, when and how?

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# Part of Umeå university and Swedish university of agricultural science (SLU)



- “ Environmental and energy economics
- “ More than 30 researchers
- “ More than 10 nationalities



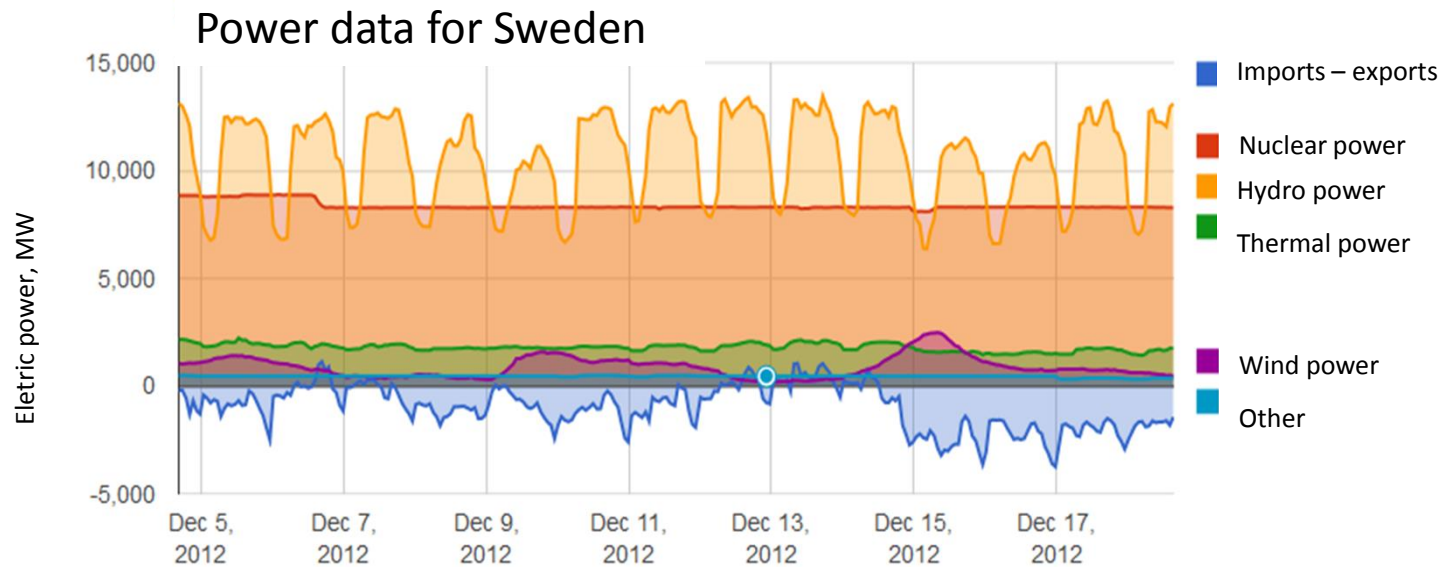
# The challenge for power systems

- ” Instant balance between production and consumption of power (Mw)
  - . More intermittent power production (wind, solar)
  - . Integration of European power systems

Need for more flexible resources

- Hydro power (other flexible production)
- Demand side flexibility

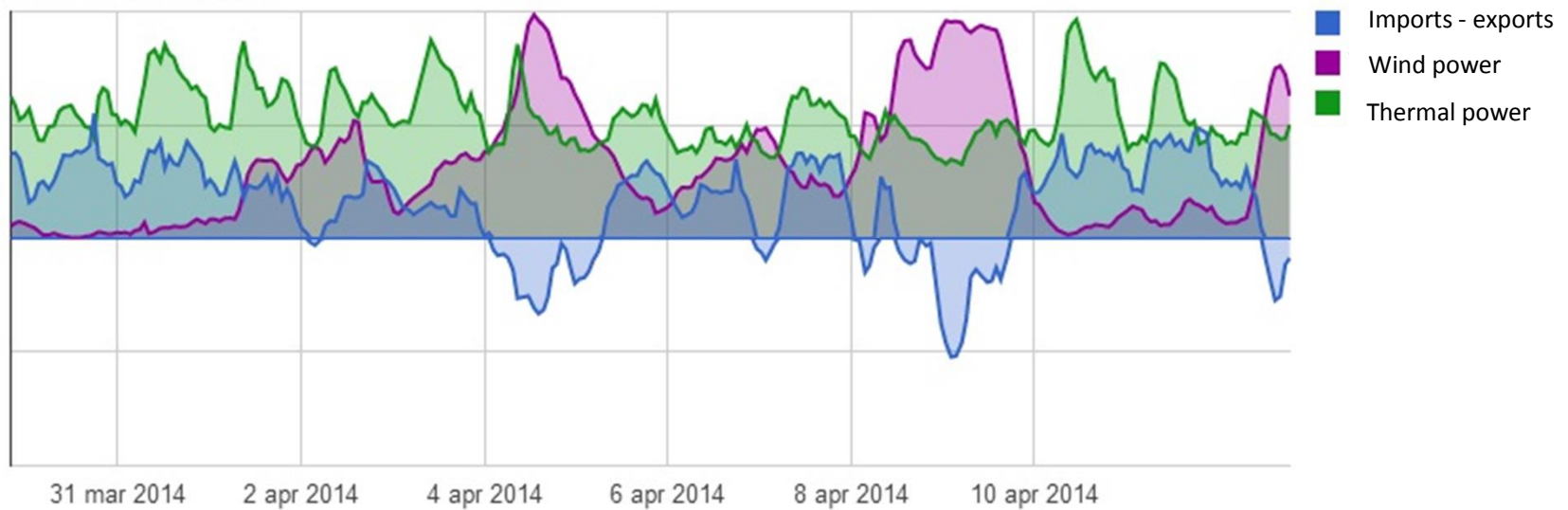
- “ Hydro power regulates variations in wind power
- “ Cold days net import is positive



Source: [www.elstatistik.se](http://www.elstatistik.se)

Denmark has a lot of wind power which is regulated by thermal power, and hydro power from Sweden and Norway

Power data for Denmark



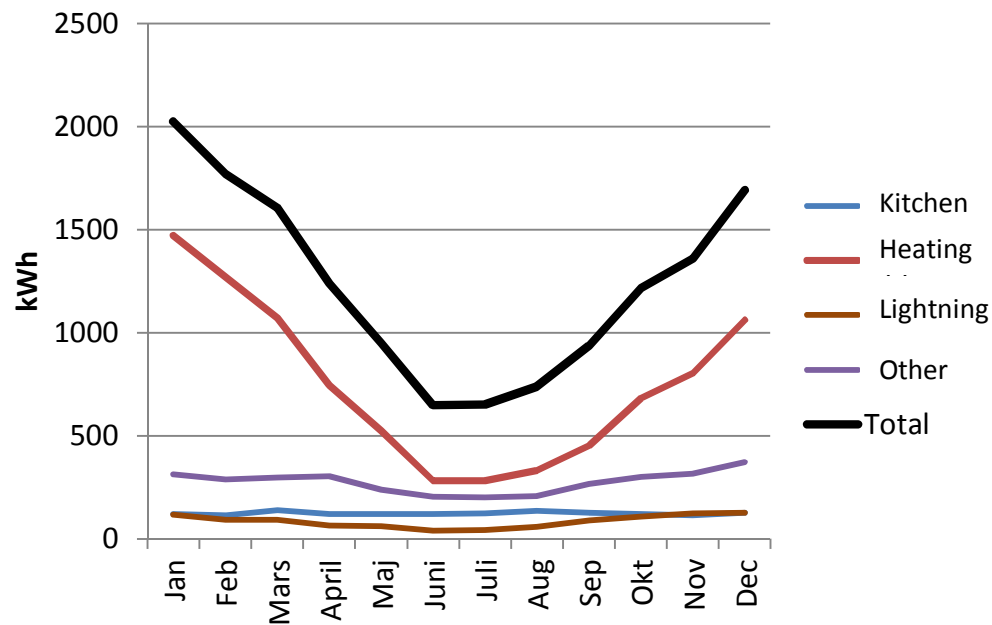
Source: [www.elstatistik.se](http://www.elstatistik.se)

## **The challenge for the power system**

- Can load shifting among households make a difference?

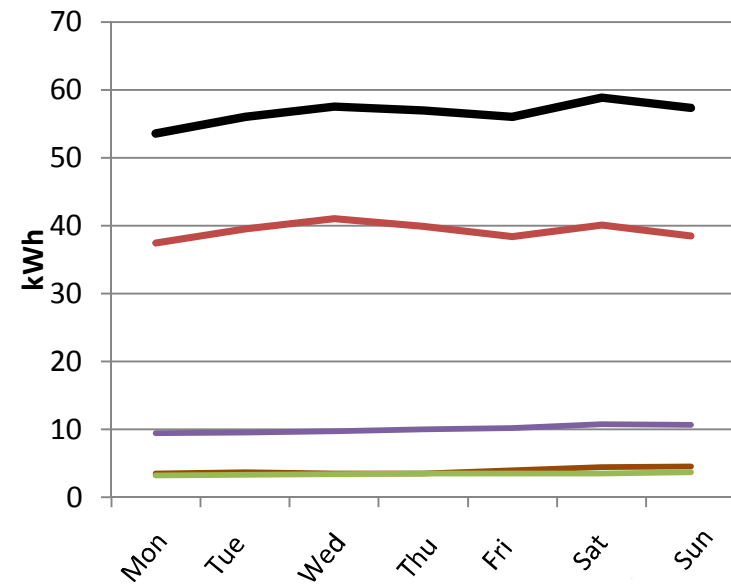
# The electricity use of Swedish households (unique detailed dataset)

Electricity use per month



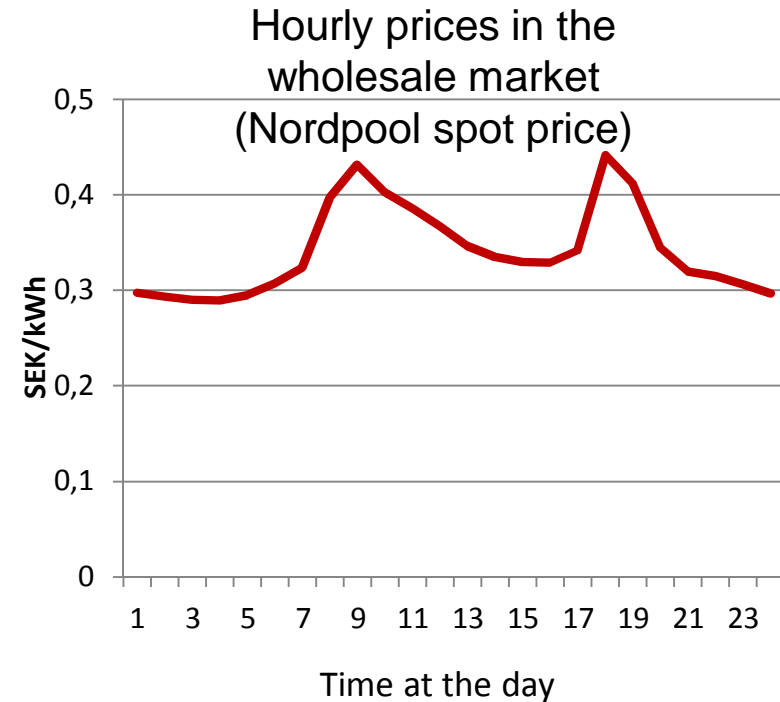
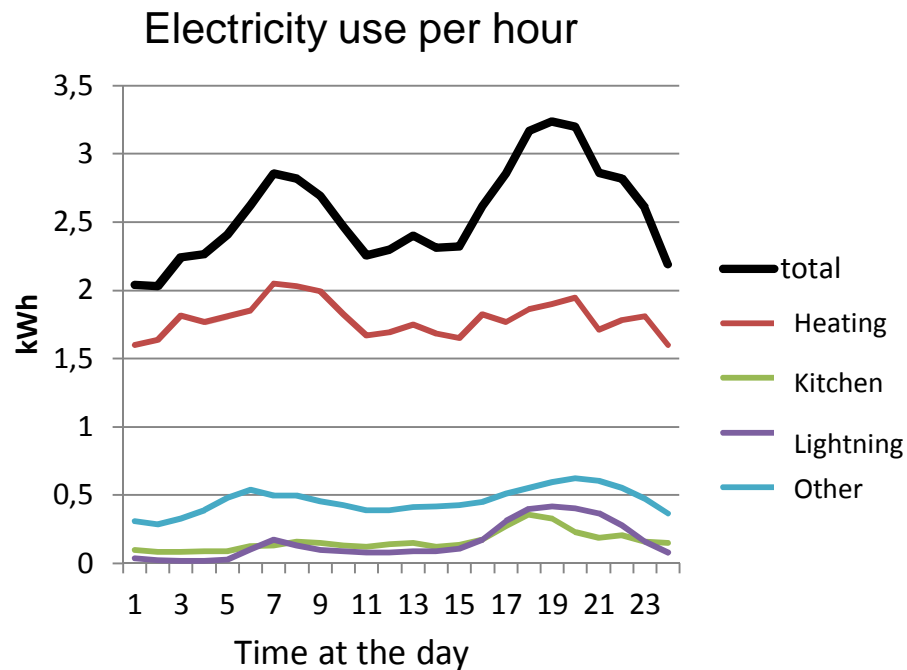
- “ High use in winter, low use in summer
- “ Heating dominant

Electricity use per day



- “ Almost constant
- “ More use in weekends

# The electricity use of Swedish households (unique detailed dataset)



“ Two peaks, morning and evening

“ Peaks occur when the price peaks.

“ Hourly prices are largely determined by demand.



## **The challenge of the power system**

- How can we stimulate load shifting among households?

# Consumer flexibility

## (1) Demand response through dynamic pricing

### (real time metering and billing)

- . Wholesale market: Hourly spot prices
- . Retail market in Sweden: Most commonly fixed prices (at least one month)
- . High expectations on RTP, but how flexible are the households?
  - “ Consumers like small bills, but ð
  - “ Electricity is a necessity in a modern society and our electricity follows the rhythm of the society
- . Expensive investments with little effect?

# Consumer flexibility

## (2) Demand side management

- Trade with power reductions/restrictions
- Is it possible to create relevant and credible products (additionally) ?
- Aggregators, the link between the consumers, electricity retailers and the grid operators.

# Consumer flexibility

Real time pricing, how much can the households save on being flexible in their electricity use?

Percentage reduction of daily cost for electricity:

Shift of load profile	Median use	Large use	Small use
1 hour	0,00	-0,15	0,42
3 hours	0,77	0,77	2,29
5 hours	1,58	1,82	3,96
7 hours	2,15	2,44	4,80

- “ 7 hours shift (e.g. dinner at 01.00 a.m.) less than SEK 1 [” 0,01] in daily cost reduction.
- “ Still overestimated (if many engage in load shifting less savings can be done)

## More knowledge neededÅ

- “ Too much focus on technical feasibility
- “ Little knowledge about the consumers preferences
- “ How flexible are households?
  - . How do they react on uncertainties
  - . How high are the transaction costs of load shifting?

## What is the cost of flexibility?

- . Utility losses when we have to do things at times we do not chose to or not do them at all.
- . The dishwasher may operate at a lower cost, but the cost of unloading it may be higher (e.g., if it has to be done in the morning just before unloading of the washing machine and feeding and dressing the children).
- . Turning down the heat during peak hours creates variations in the indoor comfort (and may increase the total energy consumption in badly insulated buildings).

## **The challenge for the power system**

- At what compensation level are households willing to be flexible?

It depends on when and how

# Choice experiment Æ DSM

- . People chose one of three hypothetical specification of a contract with their utility company.
- . The contract consist of several attributes
- . People chose contracts based on the attributes → Reveale their preferences and valuations
- . Two main types of attributes
  - " External restrictions on the household's energy use
  - " Information sharing (integrity)



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ATTRIBUTE	Levels
<b>EXTERNAL CONTROL OF HEATING, MONDAY-FRIDAY</b>	<p>A firm, e.g. a utility company, controls your heating system every day, Monday to Friday during certain hours. The heating will be turned off but the temperature never decreases more than two degrees (Celsius) and never below 18 degrees (Celsius). The control will take place</p> <ul style="list-style-type: none"><li>• 7am to 10am</li><li>• 5pm to 8pm</li><li>• Never (as today)</li></ul>
<b>EXTERNAL CONTROL OF DOMESTIC ELECTRICITY, MONDAY-FRIDAY</b>	<p>A firm, e.g. a utility company, controls your domestic electricity use every day, Monday to Friday during certain hours. During these hours it is not possible to use the dishwasher, the laundry machine and dryer. In addition, the electricity for towel warmers and comfort floor heating will be cut off. The control will take place</p> <ul style="list-style-type: none"><li>• 7am to 10am</li><li>• 5pm to 8pm</li><li>• Never (as today)</li></ul>
<b>EXTERNAL CONTROL IN EXTREME CASES</b>	<p>During certain days there are extreme situations on the energy market due to e.g. extreme cold or low production. You will be notified one day ahead that the heating system and domestic electricity will be turned off the coming day between 7am and 8pm (including weekends). The control implies the same restrictions as in the attributes above. Extreme situations are more or less random and will be limited to a certain number of days per year.</p> <ul style="list-style-type: none"><li>• 3 days per year</li><li>• 7 days per year</li><li>• 10 days per year</li><li>• Never (as today)</li></ul>
<b>DISTRIBUTION OF INFORMATION</b>	<p>Information from your electricity meter and similar can be communicated to companies and compared to neighboring and similar households. Each household is kept anonymous in the comparisons.</p> <ul style="list-style-type: none"><li>• Yes – It is okay to spread information about my household consumption and use it in anonymous comparisons across e.g. the neighborhood.</li><li>• No – It is not okay to spread information about my household consumption and use it in anonymous comparisons across e.g. the neighborhood.</li></ul>
<b>COMPENSATION</b>	<p>A new contract is related to an annual monetary compensation.</p> <ul style="list-style-type: none"><li>• 300 SEK</li><li>• 750 SEK</li><li>• 1500 SEK</li><li>• 2500 SEK</li></ul>

### Question XX

Which contract, A, B or C, would be your choice?

Everything not given by the suggested contracts are as it is today, e.g. with respect to price and type of contract.

Mark one of the contracts.

	Contract A	Contract B	Contract C – as today
<b>EXTERNAL CONTROL OF HEATING, MONDAY-FRIDAY</b>	5pm-8pm	7am-10am	No
<b>EXTERNAL CONTROL OF DOMESTIC ELECTRICITY, MONDAY-FRIDAY</b>	7am-10am	No	No
<b>EXTERNAL CONTROL IN EXTREME CASES</b>	No	Max 10 days	No
<b>DISTRIBUTION OF INFORMATION</b>	Yes	No	No
<b>COMPENSATION (SEK PER YEAR)</b>	1 500	750	0
<b>My choice (mark)</b>	[ ]	[ ]	[ ]

## Valuation of attributes

	Annual compensation (Ö1=SEK10)
<ul style="list-style-type: none"> <li>External control of heating 07-10 a.m.</li> </ul>	Not sign.
<ul style="list-style-type: none"> <li>External control of heating 05-08 p.m.</li> </ul>	SEK 630
<ul style="list-style-type: none"> <li>External control of household electricity 07-10 a.m.</li> </ul>	SEK 829
<ul style="list-style-type: none"> <li>External control of household electricity 05-08 p.m.</li> </ul>	SEK1435
<ul style="list-style-type: none"> <li>External control in extreme cases</li> </ul>	SEK 44 / day
<ul style="list-style-type: none"> <li>Distribution of information (for peer comparisons)</li> </ul>	SEK 244 (high St.d.)
Just to consider any restriction of energy use <ul style="list-style-type: none"> <li>People require</li> </ul>	SEK 2746

- ” How much do we have to pay households to:
- ✓ make them look at mountains of unwashed plates and cloths in the evening.
  - ✓ worrying about 10 potential days with restrictions on their energy use.
  - ✓ knowing that their neighbors probably see how much electricity they consume?

→ On average SEK 2118 . 4865 per year



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” How much do we have to pay households to make them :

- ✓ not wash or do their dishes in the morning.
- ✓ not worry about days with restricted energy use
- ✓ keeping their secrets (no info. sharing)

→ On average SEK 829 . 3575 per year



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thusÅ

- “ People require far more in compensation than the current benefits from extreme load shifting.
- “ We measure the compensations households require to stand certain restrictions in their energy use, which is not perfect measures of prices on real demand flexibility.
- “ You get what you pay for  
low compensation → small effect on power demand (additionally?)

# Conclusions

- . Consumers flexibility is difficult to create
  - Real time pricing the right way?
  - Can reliable DSM products (e.g., contracts) be developed?
  - Other alternatives: Supply side flexibility.
- . Cost-efficient solution wanted
  - Acceptable security of supply to the lowest possible cost to society (including utility losses among households).